Reliability of different methods for diagnosis of approximal carious lesions

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ABSTRACT

The aim of this study was to evaluate the diagnosis accuracy of approximal caries by visual, fiber optic transillumination (FOTI) and bitewing radiograph examination performed by two observers.

A total of (372) unrestored posterior permanent approximal surfaces of (186) patients were examined in Conservative Department during final clinical examination for under-graduate students, using the diagnostic methods under the study. The results were compared with the validation.

The accuracy of each diagnostic method for identification of cavitated carious lesions was expressed by the terms: sensitivity, specificity and predictive values.

The sensitivities for identification of cavitated lesions using visual examination about (0.28), for FOTI and radiography were (0.04) and (0.59) respectively. The specificity collectively was about (0.9).

On the basis of these results, it was concluded that FOTI was the least reliable of the diagnostic methods tested. Also, it was found that visual examination should precede the radiographical examination for identification of cavitated carious lesions.

Key Words: Diagnosis, caries, approximal caries.

الخلاصة

الهدف من هذه الدراسة هو لمعرفة مدى دقة تشخيص التسوس بواسطة الفحص السريري وبواسطة جهاز (FOTI) وباستخدام الفحص الشعاعي (العضة المجنحة) وتم الفحص من قبل طبيبين.

تم فحص (٣٧٢) سطح سني متقارب لأسنان دائمية حيث فُحِص (١٨٦) شخص بالغ في قسم العلاج التحفظي أثناء الامتحان السريري النهائي للدلابة، وباستخدام الطرق المذكورة آنفاً للفحص، وتمت مقارنة النتائج مع طريقة للتقييم.

تم تقييم مدى دقة طرق التشخيص المستخدمة في البحث باستخدام المصطلحات التالية: الحساسية، النوعية والقيمة التنبؤية.

كانت الحساسية للفحص السريري (٠,٢٨) بينما كانت باستخدام جهاز (FOTI) (٠,٤) وباستخدام الفحص الشعاعي كانت (٠,٥٩) وبالنسبة للنوعية كانت تتراوح بين (٠,٨٧ - ٠,٩٩).

استناداً إلى هذه النتائج أظهر البحث أن استخدام جهاز (FOTI) كان أقل واقعية في تشخيص التسوس من بقية الطرق المستخدمة في البحث، وأظهرت النتائج أيضاً أن الفحص السريري يجب أن يسبق الفحص الشعاعي لتشخيص التسوس الجانبي للأسنان.

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INTRODUCTION

For individual treatment planning, caries in approximal surfaces has traditionally been diagnosed by clinical examination combined with radiography. It has been shown to be difficult to estimate the depth of a lesion or the presence of cavitation from a conventional clinical examination as well as from an examination with fiber optic transillumination (FOTI) [1, 2].

Bitewing radiographs have been found inadequate for the identification of cavitated lesion [3].

In some conditions the lesions may arrest after a phase of demineralization and leave a "scar", a demineralized zone in the inner enamel and dentin [4]. The outer part of the enamel demineralization may be well remineralized, so the dynamic of the caries lesion should be kept in mind when caries diagnostics and treatment decision are based on radiography [5].

Radiographs need to be quite dark with a good contrast to provide the optimal basis for caries diagnosis [2]. The accuracy for radiographically detecting small approximal lesions that are histologically in the enamel has been reported to be not much higher than can be obtained by chance [6].

It should be noted that in radiograph, a distinction between the active caries lesion and the arrested lesion with a well mineralized outer surface can not be made [7].

An alternative method for detecting approximal caries is the use of fiber-optic transillumination (FOTI) [8]. It was reported that an average (73%) of the dentinal lesions in posterior approximal surfaces seen on bitewing radiographs was detected by (FOTI) as well. Ninety nine percent of the surfaces diagnosed as sound by radiography were also diagnosed as sound by (FOTI) [8]. Other study shows that lesions detected in enamel by (FOTI) were assessed to be in dentin in the bitewing radiographs [9].

The aim of this study was to evaluate the diagnostic accuracy of conventional visual and tactile examination, fiber optic transillumination, and bitewing radiography for identification of cavitated carious lesions in contacting approximal surfaces and this was validated by direct visual and tactile inspection following tooth preparation.

MATERIALS AND METHODS

The sample consists of (186) patients, (117) males and (69) females with mean age of (22.8) years. Those patients represent the examination cases during clinical final examination of dental students in Conservative Department, College of Dentistry, University of Mosul. The clinical selection criteria were that any posterior tooth with two contacting surfaces which should be without fillings. There were (162) molars teeth and (24) premolars teeth, so the available surfaces for examination in total were (372) surfaces. Those surfaces were assessed independently by two examiners (observer 1 & 2). For visual and tactile examinations, used operating light, mouth mirror, straight and hooked probes. Dental caries scale was used for examination of the surfaces (for criteria, see table 1).

The examined surfaces were kept dry by cotton rolls, compressed air and suction apparatus. Immediately after the visual examination the surfaces examined by (FOTI) (Dental Elektronic, Denmark, with 2.1 watt lamp and a probe 2mm in diameter) using a 3-point scale for recording shadow depth (table 1).

Table (1): Scoring criteria used visual, FOTI and radiographic examination with validation method

Visual Examination	
Disease Severity Scale	0 = Sound 1 = Non-cavitated Caries* 2 = Cavitated Caries
FOTI Examination	
Shadow Depth Scale	0 = Sound 1 = Shadow in Enamel 2 = Shadow in Dentin
Radiographic Examination	
Lesion Depth Scale	0 = Sound 1 = Radiolucency in Outer Half of Enamel 2 = Radiolucency in Inner Half of Enamel 3 = Radiolucency in Outer Third of Dentin 4 = Radiolucency in Inner Third of Dentin
Validation Scale	
0 = No Cavitation, Only Caries	1 = Cavitation
* Caries including whitish and discoloured lesions.	

During (FOTI) examination the operatory light was turned off, the tip of the fiber-optic probe was placed apically to the contracting point of the two approximal surfaces and angulated to maximize the illumination of the dental hard tissues. Surfaces were kept dry as for the visual examination.

Before these two examinational methods bitewing radiograph was taken for each patient. The radiographs were examined in random order on view box, by the two observers using lesion depth scale (table 1). The radiographs were read independently of the data obtained by these examinations. The surfaces that did not show any sign of caries by the (3) methods available in this study were considered as sound surfaces and did not prepared for restorations, other surfaces were prepared for conservative treatment using high-speed handpiece, and during cavity preparation the direct visual inspection was used as validation for the three diagnostic methods under study. The equipment used for validation was identical for that used for visual examination (table1).

Each observer's performances with the visual, (FOTI), and radiographic examination were validated against his / her validation scores, and the diagnostic accuracy for identification of cavitated carious lesions was expressed by terms, sensitivity, specificity and positive and negative predictive values.

The diagnostic thresholds for cavitation were: score (2) for visual and (FOTI), and scores (3) + (4) for radiographic examination.

RESULTS

The surfaces that considered sound and not exposed to preparation formed about (58.7%) of the examined surfaces. By the validation method the mean of the cavitated carious lesions recorded by the two observers were (114) surfaces. Comparison between visual examination and the validation show that an average (58%) of the experimental teeth surfaces scored as sound (score 0), of these up to (3.5%) were cavitated. Surfaces recorded as carious without cavitation (score 1), of them, up to (13.6%) were validated to be cavitated. In surfaces visually found to exhibit caries with cavitation (score 2), the diagnosis was confirmed in (91%) of the cases (table 2).

Table (2): Visual examination compared with validation

Visual Examination			Validation
Score	No.	%	Percentage of Cavitated Surfaces
0	192	51.62	3.5
1	147	39.51	13.6
2	33	8.87	91.6

Comparison between (FOTI) examination and validation about (90%) of all surfaces were assessed as sound (score 0), of these up to (5.7%) were cavitated. Of surfaces with shadow confined to enamel (score 1), (46%) were cavitated. Surfaces with shadow into dentin (score 2) all of them show cavitation in validation (table 3).

Table (3): FOTI examination compared with validation

FOTI Examination			Validation
Score	No.	%	Percentage of Cavitated Surfaces
0	334	89.78	5.7
1	34	9.14	96
2	4	1.08	100

Comparison between radiographic examination and validation an average (39.5%) surfaces were assessed as sound (score 0). Of these, up to (4%) were cavitated; of surfaces with radiolucency in outer part of enamel (score 1) up to (8%) were cavitation, and of surfaces with radiolucency in inner part of enamel (score 2) up

to (9%) were cavitated. Of surfaces with caries in outer one third of dentin (score 3) (60%) were found to be cavitated, while the corresponding percentage for surfaces with caries in the inner two thirds of the dentin (score 4) greater than (80%) (table 4).

Table (4): Radiographical examination compared with validation

Radiographical Examination			Validation
Score	No.	%	Percentage of Cavitated Surfaces
0	147	39.52	4
1	69	18.54	8
2	51	13.71	9
3	90	24.19	60
4	15	4.04	80

The diagnostic accuracy for each observer with the different diagnostic methods was expressed by several ways, traditionally by sensitivity, specificity and predictive values.

In theory, the sensitivity and specificity are independent of the disease prevalence, although the predictive values are influenced [10].

Table (5) shows the results of diagnostic accuracy. The sensitivity for identification of cavitated carious lesions by visual examination about (0.28), while the positive predictive values for the same method were (0.91). By (FOTI), the presence of a dentin shadow using as criterion for cavitation, sensitivities for this methods about (0.04), positive predictive values for the same methods (0.33).

By radiographs the sensitivities for identification of cavitation, using the criterion that caries was seen in dentin about (0.59), specificities and positive predictive values about (0.87) and (0.62), respectively.

Table (5): Accuracy of visual, FOTI and radiographic examinations for the identification of cavitation

Examination	Sensitivity	Specificity	Positive Predictive Values	Negative Predictive Values
Visual (Score 2 = Cavitation)	0.289	0.992	0.916	0.761
FOTI (Score 2 = Cavitation)	0.041	0.999	0.333	0.945
Radiographic (Score 3 + 4 = Cavitation)	0.594	0.870	0.628	0.833

DISCUSSION

The outcome of the caries diagnostic process is the decision for treatment. The decision comprises several diagnostic elements including detection of the lesion, determination of lesion activity and state, and evaluation of patient factors that might influence a change in lesion state [11].

By visual examination more than half of the surfaces under study were assessed as sound; from these (3.5%) of surfaces were found as cavitation after direct inspection (validation). This results is in agreement with the results obtained by Hintze, who found that (2.6%) of surfaces visually sound were exhibit cavitation after direct inspection following (3) days teeth separation [9]; while this finding differs from the results obtained by others where (21%) of visually sound surfaces were cavitated after direct inspection following (24) hours tooth separation [1].

The visual examination of the present study also reveals that (91%) of surfaces reported to have caries with cavitation, were assessed as cavitation after direct inspection (validation), and these results differs from that obtained by Hintze who found that of surfaces reported to have caries with cavitation, only (57%) of them show cavitated caries after teeth separation [9]. This difference in the percentage may be due to the methods of examination: in the present study we used the straight and hooked probes for detection of the proximal caries while in Hintze's study, the probes were not used to physically explore cavitations. Comparison between the positive predictive value of visual examination with the values obtained from FOTI and radiography, the visual examination show higher values than the other two. In practice, this means that the probability of cavitation is higher in surfaces visually assessed to exhibit caries with cavitation than in surfaces with a shadow or radiolucency extending into the dentin. The lower sensitivity found for visual examination, as compared with radiographic methods, may be due to presence of the proximal caries sometimes in area that can not be explored by the examiner or may be due to heavy contact of the proximal surfaces in some patients under the examination.

By FOTI, where the shadow in the dentin used as a sign of cavitation. By this method, less than one fourth of the number of carious lesions detected by visual and radiographic examination were reported. This result corresponded to the results reported by other studies [8, 9, 12].

The low sensitivity value of this method may be due to that with FOTI examination we considered a shadow seen in the dentin as sign of cavitation; and the majority of shadows reported were assessed to be confined to enamel only.

On the basis of low sensitivity and positive predictive value obtained by FOTI, it seems to be obvious that this method should not be the method of choice for the identification of approximal surfaces of permanent posterior proximal caries. From other studies demonstrated that the extent of caries lesions in general is less profound by FOTI than by radiography [8, 12].

By radiographic examination (4%) of the sound surfaces were found to be cavitated after validation. This is in agreement with Hintze's results [9] that (1.3%) of sound surfaces show cavitation after separation. The radiographical examination results revealed also that of surfaces exhibiting radiolucency in outer and inner part of enamel about (8%) and (9%) respectively shows cavitation on validation. This result is in agreement with other study [13] that found cavitation up to (10%) in such cases and also in agreement with the study [9] that revealed an average (5%) of the surfaces show cavitation after separation from surfaces exhibit radiolucency in enamel; but the

results of the present study disagreed with the results of other study [14] that found (61%) of surfaces with enamel radiolucencies show cavitation. Surfaces show radiolucencies in outer and inner parts of dentin about (60%) and (80%) respectively, reported cavitation. These percentages slightly differed than that reported by Hintze [9] (35%) and (78%) respectively, while others show (41%) and (100%) of the surfaces with shadow in dentin had cavitated in validation [13].

These differences may be due to the methods of validations used in the examinations. In the present study when a radiolucency in the dentin, it was used as a sign of cavitation, about (60%) of the existing cavitation could be identified. This relatively shows a sensitivity of about (0.58), associated with (0.62) positive predictive value, which indicated that only two thirds of the surfaces having dentinal radiolucency were cavitated.

These results indicated that the radiographic evidence of carious lesions seen in the dentin can not be used as a predictor for presence or absence of cavitation because distinction between active caries lesion from arrested lesion can not be made [7].

Clinical inspection of tooth surfaces can verify disease activity and state. Active caries lesions clinically are chalky, white and rough; while arrested caries may be opaque white or brownish white shiny surfaces [4].

The accuracy of radiographical examinations depends on number of factors such as: the sampling method, standardization technique, age, caries activity, dentitions and teeth types [13-16]. As a general speaking the validity for diagnosis of approximal lesions increase with increasing lesions depth.

As a conclusion for the study, practically clinical examination must therefore precede a radiographic examination in individual treatment planning, and selective radiography should be performed in cases in which a clinical examination has lead to suspected lesion.

FOTI considered as a valid method to increase the efficiency of clinical examination, so it can not be used as a method of diagnosis of proximal caries alone in posterior permanent teeth.

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